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COPPER CARBONATE PREVENTS BUNT (STINKING SMUT) OF WHEAT

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LOSSES CAUSED BY WHEAT SMUTS

Wheat smuts are almost as familiar as the wheat crop. Millions of bushels of wheat are lost annually because of smut. These losses are caused by reduced yields and by the contamination of sound grain by smut, which renders it undesirable for milling purposes until thoroughly washed or scoured. In recent years the percentages of wheat arriving at the terminal markets containing bunt (stinking smut) have been high. The market discounts for smutty wheat usually range from a few cents to 20 cents or more per bushel. The total discounts for all smutty wheat grown and marketed in the United States during the last few years have amounted to several million dollars each year. In addition to the discounts because of bunt, many millions of dollars are lost annually because of reduced yields resulting from the smuts.

Losses continue in spite of the fact that control measures have been recommended for many years. Recommended seed treatments often have been too drastic and at times have damaged the crop more than the smut would have done. The copper carbonate dust treatment, which is effective in the control of bunt of wheat and covered kernel smut of sorghum, and which does not injure the seed is simple and easily applied. The more general use of this treatment will materially reduce losses from smut.[1]

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[1] There are other dusts on the market, chiefly organic mercury compounds, which will control bunt of wheat and not cause seed injury, but generally they are more expensive and more poisonous than copper carbonate.

THREE SMUTS WHICH ATTACK WHEAT

Wheat is attacked by three smuts—flag smut, loose smut, and bunt or stinking smut. Each of these smuts is caused by a minute vegetable parasite or fungus which is spread with the seed. The fungi causing the three smuts differ from one another as much as wheat differs from oats or barley. The black smut masses or smut balls which are so familar are filled with numerous spores or seeds of the smut fungi. These spores germinate and produce small germ tubes or threads which infect the wheat and finally produce spores causing it to become smutty. Before attempting to treat seed to prevent smut it is important to know the smuts in order to be able to determine which treatment should be used. Loose smut is not controlled by surface treatments which prevent flag smut and bunt.

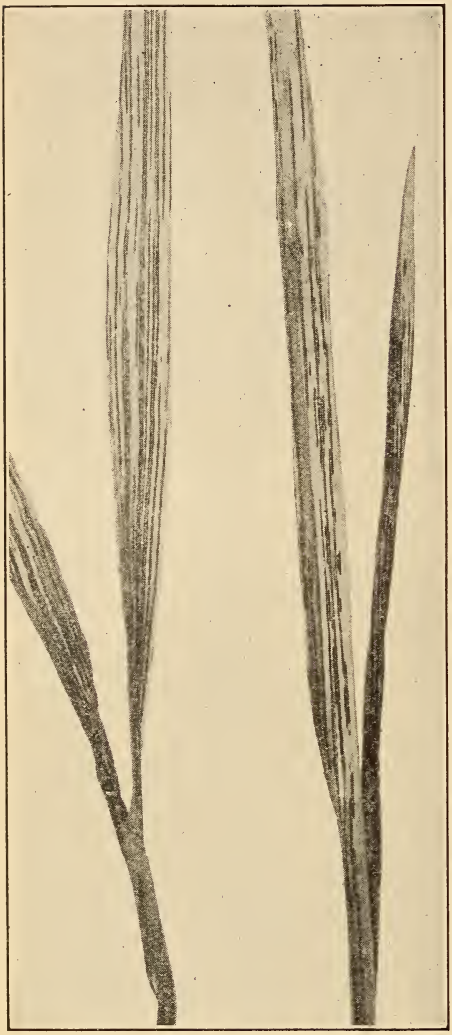

FIG. 1.—Flag smut of wheat. Note the black smut stripes in the leaves. The copper-carbonate treatment will kill flag-smut spores on the seed, but it does not prevent infection by spores that live in the soil

FLAG SMUT

Flag smut, caused by the fungus *Urocystis tritici*, was first found in this country in Missouri in 1918. It is now known to occur also in Illinois and Kansas. This disease causes heavy losses to the wheat crops in Australia and China. It also occurs in Japan, India, South Africa, Italy, and Spain. The United States has quarantined wheat from these foreign countries to prevent the entrance of flag smut into parts of this country where it does not occur. The disease is kept under control in the infested areas in the United States by quarantine measures, by seed treatment, and by growing resistant varieties of wheat.

Flag smut appears as black stripes running lengthwise in the leaf blades and sheaths of the wheat plant (fig. 1). In the early stages the stripes are somewhat lighter than the green color of the normal leaf, but later they become lead colored and finally black. These stripes are filled with the spores of the fungus. The black stripes may be seen in the leaves, especially the upper leaves, before the jointing of the plants begins. They also may often be seen in the stems. The smutted plants usually are dwarfed. The leaves and sheaths often are twisted and the diseased plants rarely head and produce seed. (For further information concerning flag smut and its control write for United States Department of Agriculture Circular 273.[2])

LOOSE SMUT

The loose smut of wheat, which is commonly known as "smut" or "blackhead," is easily distinguished from bunt and flag smut. Loose smut seldom occurs west of the Rocky Mountains, but it is prevalent in the Middle Western and Eastern States.

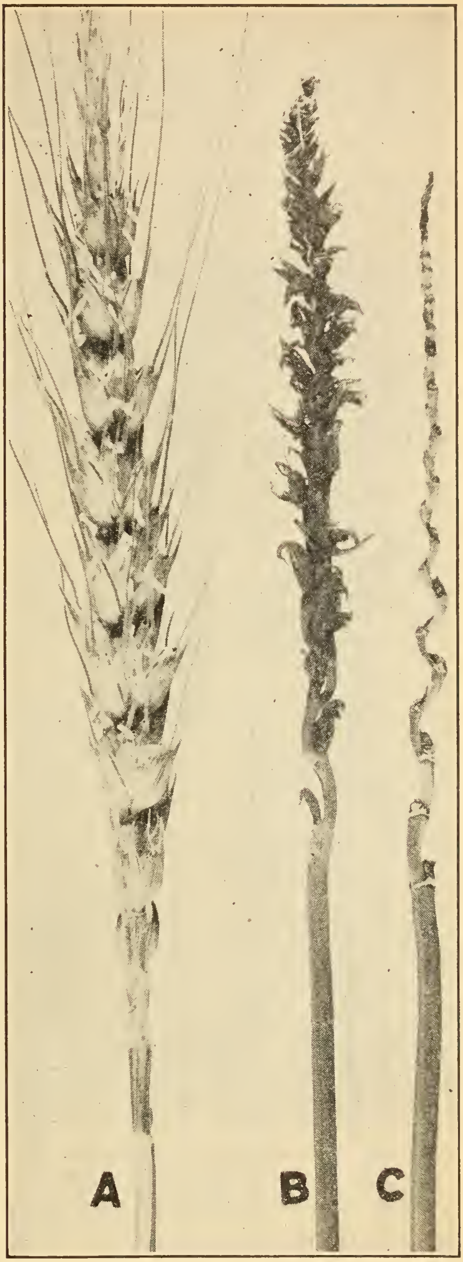

Fig. 2.—Loose smut of wheat. *A*, Normal wheat head in flower; *B*, loose smut; *C*, naked stem or rachis after smut has blown away. Copper carbonate will not prevent this smut. The hot-water treatment is necessary

As soon as the wheat heads out the smut is very noticeable. The diseased heads are almost completely destroyed by the smut (fig. 2). Instead of normal wheat kernels, black masses of smut or blackheads appear. These smut masses are filled with spores of the smut fungus, *Ustilago tritici*. The spores are easily shaken or dusted from the smutty heads and may be carried long distances by the wind or by insects or other agencies. This distribution of loose-smut spores takes place most abundantly at the time the smut-free wheat is in bloom. The spores lodge between the glumes or chaff of the sound wheat heads, where they germinate and produce small germ tubes or threads which infect the flower or the young wheat kernel.

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[2] Tisdale, W. H., Dungan, G. H., and Leighty, C. E. flag smut of wheat. U. S. Dept. Agr. Circ. 273, 6 pp., illus. 1923.

The infected kernels do not become smutty, but the fungus remains inside them while they are developing, and they can not be distinguished from smut-free kernels even when mature. If this wheat is sown without treatment the smut fungus inside starts growing as the wheat germinates, grows up in the tender tissues inside the plant, and finally produces spores in the heads of the plant causing them to be smutty.

In view of the fact that the smut fungus is carried inside the seed wheat, it is necessary to apply a treatment which will kill it under these conditions. Surface disinfectants which control bunt of wheat and other surface-borne smuts will not control loose smut. The hot-water treatment is recommended for the control of this disease. If the hot-water treatment is used it will also kill bunt spores which may be on the seed. (For further information concerning loose smut see United States Department of Agriculture, Farmers' Bulletin 939 and Department Bulletin 138.[3])

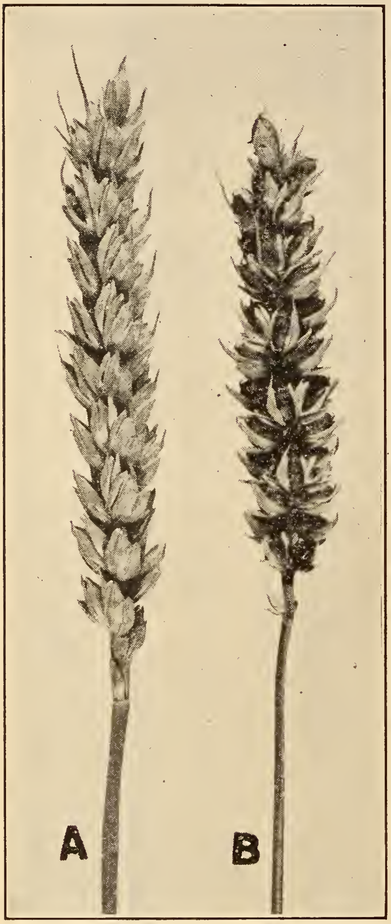

FIG. 3.—Bunt or stinking smut of wheat. *A*, Sound head; *B*, bunted head. Note the black smut balls between the chaff. Copper carbonate prevents this smut

BUNT OR STINKING SMUT

Bunt is the most destructive of the three wheat smuts. It is especially destructive in the Pacific Northwest and is a factor in production wherever wheat is grown. In addition to causing losses in the field this smut renders the sound grain undesirable for milling purposes until it has been thoroughly scoured and washed. These operations are expensive. Heavy losses because of dockage also occur. Two species of the genus Tilletia cause bunt. One of these, *T. tritici*, is confined largely to the West, whereas the other, *T. laevis*, occurs principally in the eastern part of the country. The smuts caused by these two species are so nearly alike that it will not be necessary to discuss them separately.

Bunted wheat plants can not be detected with certainty until they have headed. Often there are signs which indicate that the plants are infected. They may be more or less stunted and have a bluish green color somewhat darker than normal. After heading the heads also may appear bluish green, and they generally are distorted or abnormal in shape. The smut balls which replace the wheat kernels may develop sufficiently to spread the glumes or chaff apart. (Fig. 3.)

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[3] TAPKE, V. F. SINGLE-BATH HOT-WATER AND STEAM TREATMENTS OF SEED WHEAT FOR THE CONTROL OF LOOSE SMUT. U. S. Dept. Agr. Bul. 1383, 29 pp., illus. 1926.

HUMPHREY, H. B., and POTTER, A. A. CEREAL SMUTS AND THE DISINFECTION OF SEED GRAIN. U. S. Dept. Agri., Farmers' Bul. 939, 28 pp., illus. 1918.

After the crop is mature these bunted heads appear darker than normal. This color is due to the mass of dark or almost black smut spores which make up a large part of the smut balls (fig. 4). When broken open these bunt balls have a disagreeable odor resembling that of decaying fish.

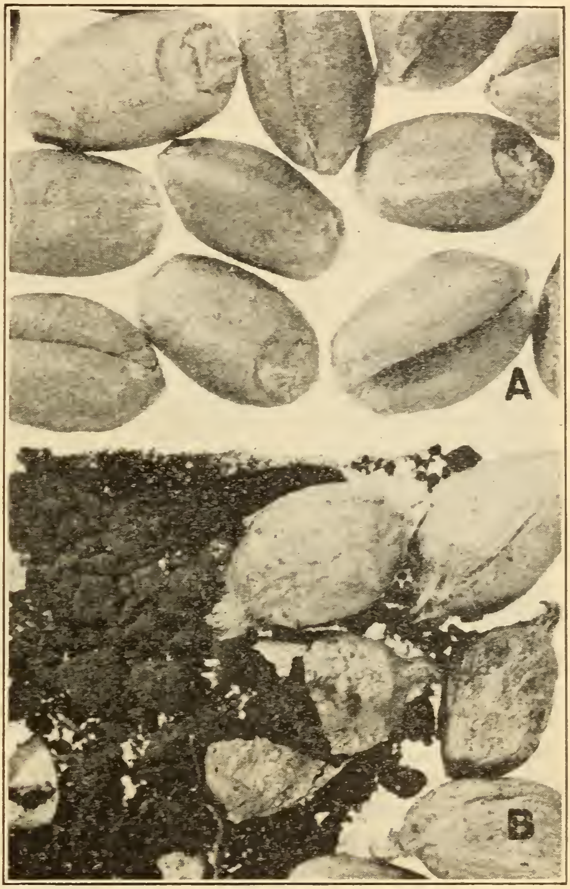

FIG. 4.—Bunt or stinking smut of wheat. *A*, Sound wheat; *B*, bunt, which is prevented by the copper-carbonate treatment of seed. (Enlarged.) Bunt is the only one of the wheat smuts having a foul odor

During harvesting and threshing operations many of the smut balls are broken and the spores are thoroughly mixed with the sound wheat. If this wheat is used for seed and sown without treatment the smut spores germinate as the wheat germinates. The minute germ tubes produced by the spores enter the young wheat plants. The fungous threads developed from the germ tubes grow up through the tender tissues as the plants grow. They finally enter the heads and produce spores in smut balls which take the place of the wheat kernels.

In the Pacific Coast States where dry weather prevails during the late growing period and after the crop is mature, wheat is infected also by bunt spors which live in the soil from harvest time until the next crop is sown. Infection takes place in the same way as if the spores were carried on the seed. In the Palouse district of eastern Washington, northwestern Idaho, and northeastern Oregon bunt is abundant, and during the dry harvest and threshing season clouds of smut spores are blown over the country from harvesting and threshing operations. These spores may be carried many miles. Even virgin land will not be free from infestation, as the spores are distributed everywhere. The infestation is heavier, of course, near threshing machines and on the leeward side of hills, where the spores settle in greater abundance. Under such conditions seed treatments which are satisfactory elsewhere are less effective. Soil infestation is not an important problem east of the Rocky Mountains.

THE COPPER-CARBONATE TREATMENT

A number of measures are practiced for the control of bunt. Among these are the selection of smut-free seed, seed treatment, certain cultural practices, and the growing of bunt-resistant wheats. The development of bunt-resistant wheats has much promise for the future, but as yet this phase of bunt control is in the experimental stage and wheat growers must rely on seed treatment. In recent years the copper-carbonate dust or dry treatment for the prevention of bunt has come into use. It is the most satisfactory treatment known. It is just as effective in control as the copper-sulphate-lime and formaldehyde treatments and is more satisfactory in other respects.

TYPES OF COPPER CARBONATE

There is considerable interest concerning the best type of copper carbonate for seed treatment. A very finely ground, light-green basic copper carbonate especially prepared for seed treatment should be used. Some material of poor grade has been placed on the market and used, as a result of greatly increased demands on manufacturers who were without available knowledge as to what was needed. The situation is now greatly improved. It is not difficult to obtain satisfactory copper carbonate manufactured especially for seed treatment. There are some complaints of shortage, but this condition in most cases can be met by a little forethought in placing orders.

Generally speaking, two types of copper carbonate are obtainable. One contains about 52 per cent of copper and is known as pure copper carbonate. The other contains less copper and is known as the "diluted" or "extended" form. Where soil infestation is serious, as in the Pacific Northwest, the latter type according to some reports has not proved as effective as the former in the control of bunt in wheat. In the regions where no soil infestation occurs both types have proved satisfactory.

QUANTITY OF COPPER CARBONATE TO USE

Two ounces of copper carbonate to the bushel of wheat, if properly applied, is sufficient under most conditions. As much as 3 ounces to the bushel has been recommended at times, where seed or soil infestation, or both, are very heavy. This is especially true when the "diluted" type of carbonate is used. If conditions are such that more than the usual application seems necessary, no harm will be done if 3 ounces or even more is used, as it is not likely to injure the seed. If it becomes necessary to sow seed black with smut it is advisable to treat it with formaldehyde or with copper sulphate instead of copper carbonate. (See United States Department of Agriculture, Farmers' Bulletin 939, for methods of applying these treatments.[4]) Such badly infested seed, however, should be avoided.

APPLICATION

Copper carbonate, to be effective, must completely cover the seed. The lack of satisfactory results in many cases no doubt has been due to lack of thorough application. Machines of the rotary type are best for applying the dust. The grain and the carbonate should be mixed by rotating the machine until each kernel is thoroughly covered with a thin film of the dust. The speed of the machine and the quantity of grain contained as compared with its capacity will determine the length of time necessary to rotate. Ordinarily from one to two minutes should be sufficient.

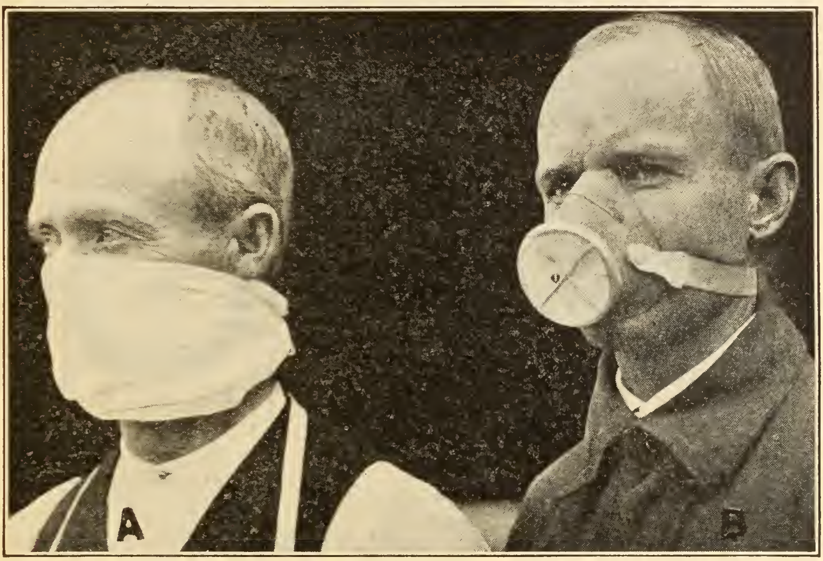

FIG. 5.—Masks for protecting the nose and throat when treating grain with copper carbonate. *A*, Wet cloth or handkerchief; *B*, commercial mask

Copper carbonate should not be mixed with grain by shoveling over on the floor. If that is done the copper carbonate dust gets into the air and when inhaled causes the operator considerable irritation and even severe nausea. A dust mask or a wet handkerchief should be worn over the nose and mouth while the grain is being treated. (Fig. 5.)

There are several commercial makes of mixing machines which are satisfactory for treating seed with copper carbonate. A tight barrel of convenient size may be used for making a mixer on the farm. (Fig. 6.) Ordinary gas pipe or other iron pipe with standard fittings may be used for the axle and crank. Bore a hole in the center of each head of the barrel so that a 1½ inch pipe will fit tightly. Thread the pipe far enough down at each end so that an iron disk may be screwed against the head of the barrel. Saw out a convenient-sized (12 inches) square opening in the side of the barrel, making the cut slanting toward the center. This piece can then be reinforced with straps of iron or pieces of wood and hinged in place to make a door in the barrel. Tack strips of leather, rubber, or thick cloth along the cut edges of the opening to make the door fit tight enough to prevent the dust from escaping. The door may be fastened by hook and clasp or by a revolving latch. A crank is fastened to one end of the axle and the barrel is mounted on a substantial rack similar to the mounting of an emery stone used for sharpening tools. The machine is then ready for use. The barrel should not be more than half full of seed and for best results not over one-third full. The more grain placed in the barrel the less agitation or mixing there will be when it is revolved. If the grain is not stirred sufficiently when the barrel is revolved, remove one head of the barrel and nail a thick board 3 or 4 inches wide edgewise the full length of the barrel. This will prevent sliding of the wheat and will aid in the mixing.

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[4] HUMPHREY, H. B., and POTTER, A. A. CEREAL SMUTS AND THE DISINFECTION OF SEED GRAIN. U. S. Dept. Agr., Farmers' Bul. 939, 28 pp., illus. 1918.

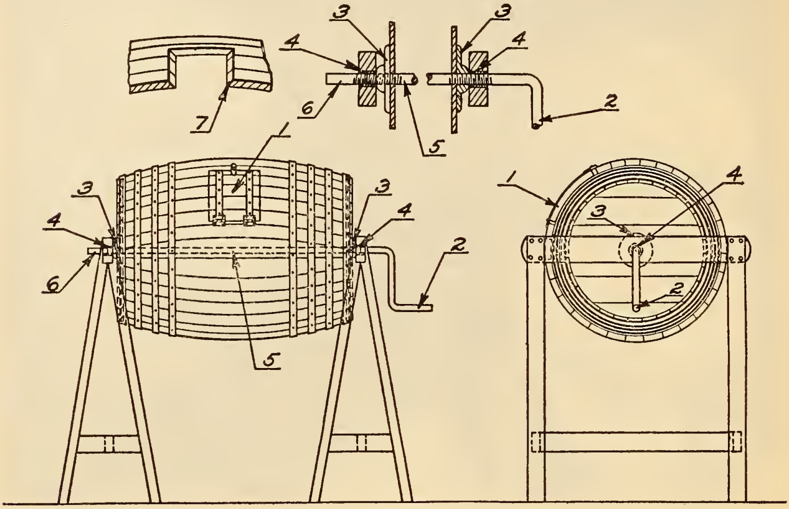

Fig. 6.—Barrel mixer for treating grain with copper carbonate. 1, Door to barrel; 2, crank; 3, disks screwed against heads of barrel to fasten it to axle; 4, threaded ends of axle; 5, axle; 6, axle extension for mounting in rack; 7, beveled cut in door (1) to prevent escape of dust

ADVANTAGES OF THE COPPER-CARBONATE TREATMENT

The copper-carbonate treatment has the following advantages:

(1) It does not injure germination. In fact, treated seed often germinates better than untreated seed.

(2) Seed may be treated whenever convenient and stored without injury. The wet methods do not permit this.

(3) Dusted seed may be planted at any time in dry or moist soil.

(4) Very little labor or expense is required to treat seed for large acreages.

(5) Copper carbonate protects stored grain from attacks by weevils. Rats and mice will not eat treated seed if there is untreated grain in the storehouse on which they can feed.

WARNING

(1) Copper carbonate is not satisfactory for the control of the smuts of oats and barley and the loose smut of wheat. It is recommended for bunt of wheat and kernel smut of sorghum.

(2) Protect your nose and throat by wearing a dust mask while treating seed with copper carbonate. Inhaled copper-carbonate dust in sufficient quantity may cause severe nausea and irritation.

(3) So far as possible avoid using heavily smutted seed, even when the seed is to be treated.

(4) If more seed is treated than is used for sowing, do not attempt to use or market the surplus for food or feeding purposes. Copper is poisonous. Bread made from wheat treated with copper carbonate is not fit to eat even if the treated wheat is thoroughly scoured before milling.

(5) Seed treated with copper carbonate should not be allowed to become wet or to stand in the seeding machine under moist conditions. Excess carbonate should be carefully and regularly cleaned from the machine. Caking of the dust may injure the seeder. It is sometimes desirable to rock the wheels of the machine back and forth before starting it, to loosen the grain.

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